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STUDIES ON MICRO-FUNGI. IX

CALCARISPORIUM, VERTICICLADIUM, AND HANSFORDIA (GEN. NOV.)

By S. J. HUGHES

Commonwealth Mycological Institute, Kew, Surrey

INTRODUCTION AND SUMMARY

IN 1851 Preuss published two monotypic generic names, *Calcarisporium*, based on *C. arbuscula* Preuss, and *Verticicladium*, based on *V. trifidum* Preuss. *C. arbuscula* was described originally on *Peziza nivea*; two collections, one old and the other recent, on *Dasyscypha virginea*, prove to be referable to *C. arbuscula* which is described also from pure cultures. *Verticillium beauverioides* Vincens is regarded as a later synonym of *C. arbuscula*; its original habitat was given as on agarics. Recent collections on *Lactarius* sp. and *Polyporus* sp. of a fungus answering to Vincens description are indistinguishable on the host and in culture, from *C. arbuscula*.

Verticicladium trifidum is described from a number of collections on the needles of *Pinus sylvestris* and its life-history is tentatively outlined. The original habitat of *V. trifidum* was stated to be 'in foliorum Pinorum' and from the original figure, the Pine is seen to be two-needled, like *P. sylvestris*. *V. trifidum* grows well in culture and its cultural characters are described. *V. acicola* Jaap is considered to be a later synonym. Notes are made on species with names in *Verticicladium* where specimens were available, and apart from *V. acicola*, none is considered to be exactly congeneric with the type species.

A new generic name, *Hansfordia*, is published, based on *H. ovalispora* n. sp. collected in W. Africa. Congeneric species include the tropical *H. togoensis* n. sp. *Verticicladium grewiae* Hansf., *V. ugandense* Hansf., *Sporotrichum canescens* Speg., *S. triumfettae* Hansf., and the temperate *Botrytis grisella* Sacc.

CALCARISPORIUM

63 **Calcarisporium arbuscula** Preuss.

In 1851 (p. 124) Preuss described his genus *Calcarisporium* and its single species as follows: '*Calcarisporium* Preuss, Stipes erectus, septatus, hyphopodio ramoso suffultus, supra ramosus apice capitato-verrucosus; verrucis sporas solitarias gerentibus. Sporae simplices basi hilo instructae. 84. *C. arbuscula* [as *arbuscu-lum*]. Caespitulis effusis lanuginosis albis; hyphopodio ramoso septato, stipitibus erectis septatis pellucidis; ramis rarissimis; ramulisque subulatis, patentibus verticillatis, apice capitulo verrucoso, sporis coronato; sporis (minoribus) simplicibus elongatis, basi hilo instructis. Habitat supra *Pezizam niveam* emortuam aestate, prope Hoyerswerda.'

As far as I am aware six authors have commented on the genus *Calcarisporium* Preuss.

Bonorden (1851, p. 284): 'The generic character agrees with *Stachybotrys*, but *C. arbuscula* has verticillate branches for which reason the genus appears to be justified, since in a manner of speaking it represents the *Verticillium* among the Basidiophores of the Hyphomycetes (indem sie gleichsam das *Verticillium* unter den Basidiophoren der Hyphomyceten darstellt).'

Saccardo (1886, p. 162): 'It seems to be a *Sceptromyces* with branches which are capitate-verrucose at the apex.'

Costantin (1888): 'This genus is close to *Sceptromyces*, from which it differs by its non-pedicellate conidia, by the absence of an elongated ear and by the presence of a warted head.'

Lindau (1907, p. 335) summed up the position when he stated: 'A picture or more accurate description of the genus was not given by Preuss so that our knowledge of it rests upon this somewhat incomplete description.'

von Höhnel (1923) assigned two collections, on old *Hypoxylon serpens* and *Agaricus*, to *C. arbuscula*; his description differs little from the one given below.

Petch (1932) considered *Calcarisporium* to be synonymous with *Cladobotryum* Nees (see p. 24).

Fortunately, Preuss always gave good accounts of the *habitat* in his diagnoses and that of *Calcarisporium arbuscula* is no exception; it is clearly stated, and before being able to feel any confidence in assigning a collection to Preuss's name we must approach this *locus natalis* as closely as possible.

In Herb. R.B.G. Kew there is a specimen in the *Verticillium candelabrum* folder labelled by Charles Crossland as follows: '2344. Y.F.Fl., *Verticillium candelabrum* Bon. On *Dasyscypha bicolor*. Goitstock wood. Wilsden. Aug. 31/'01. T. Hebden.' [Herb. I.M.I. (slide) 23804.]

The discomycete represented in this collection is *Dasyscypha virginea* (Batsch ex Fries) Fuckel according to Dr. R. W. G. Dennis who also kindly informed me that *D. virginea* could well have been called *Peziza nivea* by Preuss. The apothecia in this Yorkshire collection are devoid of asci either because the apothecia are too young or perhaps the hyphomycete was parasitic and prevented their maturation. I believe that this summer collection reproduces the *habitat* requirements delimited by Preuss; it remains to be seen whether the hyphomycete tallies with the description.

Description of hyphomycete on Dasyscypha

The hyphomycete forms a white growth over the surface of the apothecia. Septate hyphae up to 6·5 μ wide originate within the tissues of the apothecium and creep along the surface. The conidiophores (Fig. 1) either arise from the surface hyphae as erect lateral branches or are exerted from the host tissue. They are septate and vary between 70 and 140 μ long, 2 to 5 μ wide below, and 2 to 3·5 μ wide above. Sometimes two conidiophores arise from a common stalk which is branched near the substratum, otherwise the main stalk of the conidiophore ('ramis') is unbranched; the base of the conidiophore may be slightly warted. The apex terminates in a subulate sporogenous cell, up to 30 μ long and 2 to 3 μ wide below; this cell may be slightly inflated above, bearing conspicuous and irregularly disposed divergent sterigmata to which conidia are attached, or the apex may be more thread-like with the sterigmata borne along its length; on the other hand, the apex may at first be inflated and then continue growth

a thin hypha bearing similar sterigmata. The spore-bearing apical region may even be forked. A verticil of between three and six similar cells ('ramulis') measuring 12 to 26 by 2 to 3 μ is found at the immediate apex and up to four

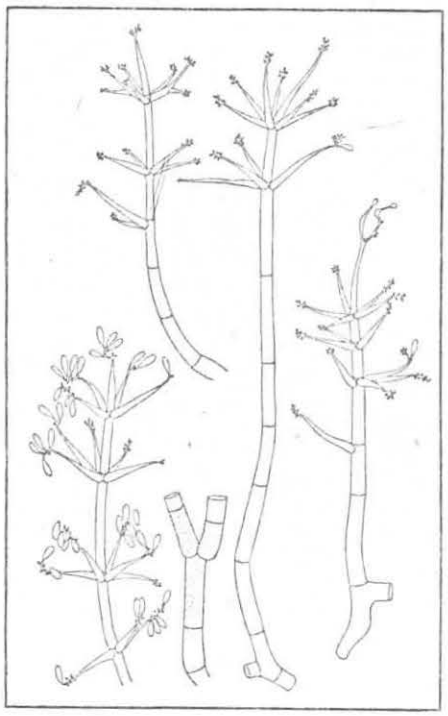

Fig. 1 **Calcarisporium arbuscula**: conidiophores and conidia from collection in Herb. R.B.G. Kew [Herb. I.M.I. (slide) 23804]. ×500.

additional similar verticils occur below the uppermost septa standing out nearly at right angles from the main stalk. The conidia are dry, hyaline, oval, tapering somewhat towards the basal scar; they measure 4 to 6 by 1·7 to 2 μ.

As far as Preuss's description goes the agreement is excellent.

British material recorded as Calcarisporium arbuscula

In 1908 A. L. Smith introduced the name into British mycology with the following description and notes; 'Tufts white, spreading, conidiophores with a few branches, the ultimate branches awl shaped, verticillate; spores elongate, rather small, with a small beak at the base. On decaying fungi. Rev. W. L. W. Kerr, Swarraton, Hants, June, 1908. No measurements or drawings are given with the original diagnosis of this monotypic genus, but Professor Lindau, to whom I have submitted it, agrees with me that it is *Calcarisporium* and probably *C. arbuscula*. The conidiophores are from $\frac{1}{2}$ to 1 mm. high, about 4 μ in width, the verticillate branches are short, 15 $\mu \times 3$–4 μ, the spores elliptical-oblong 5·7 $\mu \times 3\mu$, with sometimes a minute beak at the place of insertion.' A. L. Smith's figure is reproduced in Plate 1, Fig. 1.

In the Herbarium of the British Museum (Nat. Hist.) there is a specimen labelled by A. L. Smith '*Calcarisporium arbuscula* Preuss. On old log and on

decaying fungus, Swarraton, Hants, Leg. Rev. W. L. W. Eyre . . . A.L.S. June 1908' [Herb. I.M.I. (slide) 25891]. The fungus forms pale brown tufts and is very probably on a branch of *Fraxinus excelsior*. The conidia measure 6 to 7·5 by 3·5 to 4 μ and exactly match Herb. I.M.I. 1746, 10675, and 10677 which were collected on *Fraxinus excelsior*. These latter collections may be conidial *Daldinia concentrica* but this has not been proved. The colour, form of the conidiophores, and the habitat of A. L. Smith's collection are quite different from those described by Preuss for *Calcarisporium arbuscula* and the slide is disposed in Herb. I.M.I. as *Nodulisporium* sp. 2. Apart from a slight difference in spore measurements A. L. Smith's fungus agrees with the hyphomycete which Molliard (1904) obtained by growing ascospores of *Daldinia concentrica* in culture and for which he unnecessarily proposed the new name *Nodulisporium tulasnei* Molliard.

Reasons for choosing the form genus *Nodulisporium* Preuss for the type of conidial apparatus assigned to *Calcarisporium arbuscula* by A. L. Smith are briefly given later (p. 14).

A recent British collection of Calcarisporium arbuscula

In July 1948 Dr. R. W. G. Dennis gave me a twig bearing some *Dasyscypha virginea* apothecia; these were covered by a white mould which is identified as *Calcarisporium arbuscula*. I am grateful to Dr. Dennis for this material [Herb. I.M.I. 24674] which enabled me to start a pure culture of the mould; furthermore, because the Yorkshire collection mentioned previously, and this present one are borne on *Dasyscypha virginea* and Preuss's was described on '*Peziza nivea*' I feel greater confidence in assigning them to Preuss's name.

This recent collection had produced two sorts of conidiophores; some are only undifferentiated decumbent hyphae bearing verticils of sporogenous cells. The others are about 5 μ wide at the base and have refringent walls which are thicker than those of ordinary hyphae; they reach a length of 800 μ, are sometimes branched, and bear up to nine verticils of sporogenous cells. The conidia measure 5 to 8 by 1·5 to 3 μ.

The fungus grows well on potato-dextrose agar but produces rather too much aerial mycelium; a better growth is obtained on maize-meal agar and less aerial hyphae develop. The mycelium is composed of hyaline, septate, branched hyphae 1 to 2 μ wide. Aerial hyphae, about 2 μ wide can turn up away from the medium and develop verticils of sporogenous cells but these conidiophores are mostly repent; they resemble the undifferentiated conidiophores produced on the natural substratum. The erect conidiophores are different from the mycelial hyphae from the beginning. They arise as erect, solitary lateral branches of hyphal cells which are rather wider and thicker walled than neighbouring cells; even at their earliest stages such conidiophores are clearly differentiated from the others by the basal width of about 5 μ and the thicker refringent wall. The conidia produced in culture measure 5 to 10 by 1·5 to 2·5 μ. Scattered throughout the colonies are brown immersed sclerotia up to 250 μ in diameter.

A later synonym of Calcarisporium arbuscula

In 1916 Vincens described his species *Verticillium beauverioides* as follows: 'Caespes albus. Mycelium rarum, inordinate effusum, septatum, 2–3 μ dia-

metiens. Conidiophora numerosa, stricta, 100–150 μ longa, 3–3·5 μ crassa. Rami fertiles 5–6 in verticillos approximati, quoque verticillo ab altero 20–30 μ distante; hi rami 20–25 μ longi, ad basim 2–3 μ crassi, sensim attenuati usque ad summum, cymam aut capitulum plus minusve multiplex sterigmatum brevium gerens. Conidia ovali-elongata, 6–10 × 2–3 μ, hyalina. Supra Agaricineas.'

Vincens found the fungus arising in the laboratory on various species of *Russula* and on a *Collybia* kept for some days in a moist atmosphere. It was particularly frequent and abundant on *Russula nigricans* and as a footnote Vincens remarked that he had seen the same fungus growing on the fructifications of a *Ceratostoma*.

It was stated to grow well on different media and [aerial] mycelium was relatively rare and the conidiophores abundant. Some of Vincens's original figures are reproduced in Plate 1, Fig. 2; the fungus is a *Calcarisporium* and in fact, not obviously distinct from *C. arbuscula* Preuss.

In September 1948, whilst collecting moulds on rotten agarics I picked up a white mould on the decaying pileus of *Lactarius* sp. at Hackfall, near Masham, Yorkshire (Herb. I.M.I. 31480), which agrees with Vincens's description of *Verticillium beauverioides*. The fungus was cultured and cultures compared with those of *Calcarisporium arbuscula* [Herb. I.M.I. 24674] described above.

Both the *Dasyscypha* and *Lactarius* isolates grew at the same rate on maize-meal agar and potato-dextrose agar and no colour was produced in the medium. Sclerotia were produced by both isolates but these were far more numerous and larger, up to 350 μ diameter, in that from *Lactarius*. Maize-meal agar seemed to be the better medium for the *Dasyscypha* isolate whereas the *Lactarius* isolate produced excellent growth on potato-dextrose agar. But these differences are not very great and when the similar morphology of the conidiophores from the two isolates is considered I have no doubt that the two collections from which the isolates were derived should be referred to the same name, *C. arbuscula*; I regard *V. beauverioides* as a later synonym.

In December 1949 Mr. P. K. C. Austwick kindly handed me a small fructification of *Polyporus ? adiposus* bearing a white mould, which he had collected on a tree fern in the Temperate House, Kew Gardens [Herb. I.M.I. 38952]. The mould is *Calcarisporium arbuscula*; in culture it produced typical conidiophores but fewer and paler stromata than either of the two other isolates which have been available to me. On potato-dextrose agar the colonies were fluffy with aerial mycelium; better growth of conidiophores of both kinds mentioned previously was obtained on potato-carrot agar. Dried cultures of the three collections are preserved in Herb. I.M.I.

Calcarisporium, Beauveria *Vuill., and* Tritirachium *Limber*

A comparison of the type or cotype species of these genera is interesting. All three have one character in common and that is that the sporogenous cells (sometimes called phialides in *B. bassiana* (Bals.) Vuill.) produce terminal conidia which are in reality blown-out ends. After one conidium is formed, a new growing-point develops; a further conidium is produced and this process is repeated. In *C. arbuscula* the new growing-points appear in no regular order and an irregular head is produced at the apex of the sporogenous cell; after the conidia have fallen away the sterigmata point in all directions. In *T. dependens* Limber

(1940) [e.g. Herb. I.M.I. 1804] a beautifully regular growth results in the development of a sporogenous cell resembling the rachis of *Triticum*, a similarity which gave the genus its name. A similar more or less regular, but much shorter sporogenous cell is produced by *B. bassiana*. In *Tritirachium* and *Beauveria*, then, conidial production is accompanied by a marked increase in length of the sporogenous cell whereas in *Calcarisporium* little elongation occurs.

Beauveria bassiana may be excluded from *Calcarisporium* and differentiated from *Tritirachium* on account of its globose heads of sporogenous cells. *Tritirachium* is *Calcarisporium* with regular zigzagging sporogenous cells.

Beauveria oryzae Vincens (1923) is a good enough *Tritirachium* when these differences are borne in mind. Saccas (1948) regarded *Tritirachium* as synonymous with *Beauveria*. Langeron (1949) discussed the differences between *Beauveria* and *Tritirachium* and classified *B. heimii* as a *Tritirachium*.

VERTICICLADIUM

66. Verticicladium trifidum Preuss.

In 1851 (p. 127) Preuss published the genus *Verticicladium* for his single species *V. trifidum*; these were described as follows: '*Verticicladium* Preuss. Stipes erectus septatus, supra verticillato-ramosus; ramis subternato-decompositus, ramulis ultimis subulatis; sporae simplices in apicibus ramulorum singulatim innatae, dein deciduae. 93. *V. trifidum*. Caespitibus tenuibus, effusis, vix conspicuis, cano-fuscis; stipitibus erectis, septatis, subpellucidis, basi dilatis, supra ramosis, verticillatis, patentibus, fusco-atris, sporis globosis pellucidis albis. Habitat in foliorum Pinorum putrescentium pagina interiore; prope Hoyerswerda.'

In 1862 he figured the fungus and repeated his previous diagnosis. His figures are reproduced in Plate I, Fig. 3; it will be noticed that whereas in the text the conidia are described as globose the very highly magnified conidia in his figure are distinctly oval.

In August 1947 whilst examining the Herb. R.B.G. Kew copy of Sydow's *Mycotheca germanica* 2997 bearing *Linodochium hyalinum* (Lib.) v. Höhn. on rotting needles of *Pinus sylvestris*, some needles were observed to bear conidiophores each with a much-branched head. Indeed, the appearance under the binocular microscope was reminiscent of Preuss's habit figure of *V. trifidum*; a preparation [Herb. I.M.I. (slide) 17377] showed that the conidiophores resemble Preuss's figure and description so closely that it was disposed under Preuss's name. Two days later a collection of this fungus was made in Richmond Park, Surrey, and subsequent searches for the fungus on rotten needles of *Pinus sylvestris* have always been successful. All that this means is that we have returned to the precise *locus natalis* as described by Preuss; the fungus may well be extremely common throughout the country. When rotting needles are held up against the sky or against a white or light background the fungus can readily be recognized with a $\times 10$ or $\times 15$ lens by the sturdy black conidiophores each with a branched head which is almost triangular in outline; the head is easily knocked off, however, to leave only the stipe.

The description of the fungus that follows is based upon one German specimen and thirteen collections made in England and Wales which are listed on p. 13.

Description of Verticicladium trifidum

The *conidiophores* (Fig. 2) are found on the inner and outer curved surface of the needles and in recently invaded needles they are clearly seen to be arranged regularly in linear series. They are easily broken away from their point of attachment but a black dot remains to indicate where one was once borne. They are generally solitary but two to five are occasionally found grouped together. The stipe is unbranched, generally straight, erect, dark brown below and paler at the apex, septate throughout, thick walled and very slightly subulate upwards, but sometimes abruptly swollen at the base. They measure between 330 and 800 μ long, 8 to 12 μ wide just above the swollen basal cell, and 8 to 10 μ wide just below the lateral branches of the distal end. Below each of the apical three to four septa is found a verticil of lateral branches standing more or less at right angles to the main stalk of the conidiophore. Two to six such lateral branches are borne in each verticil, but a solitary lateral branch instead of a verticil is not at all uncommon. Each such primary lateral branch may bear secondary and even tertiary verticillately arranged branches. In a young head the end branches which are almost hyaline, measure 10 to 16 μ long and about 3·5 μ wide and have a smooth, rounded apex; in a mature head they are subulate and may reach a length of 70 μ and they bear numerous scars indicating the insertion of conidia which have fallen away.

The apical growing cell of each lateral branch, primary, secondary, and tertiary, also develops ultimately into a subulate spore-bearing cell, and below the septum, two (but sometimes only one) similar cells have arisen giving a trifurcate appearance and explaining Preuss's choice of *trifidum* for the specific epithet. In a similar manner the apex of the main stalk of the conidiophore develops this trifurcate structure and further increase in length of the stipe is checked.

The *conidia* are dry, oval, hyaline to very slightly fuscous, minutely verrucose, and are produced singly as a blown-out end at the apex; when one conidium is thus formed a new growing-point arises below it, pushing the last conidium to one side and by a repetition of this process numerous conidia are produced. Mature conidia fall away readily and this undoubtedly accounts for Preuss's statement that the conidia are borne singly at the apex. In the specimens cited the conidia measure 4 to 6 by 2·5 to 3·5 μ.

Development of conidiophores. The hyphae of *Verticicladium trifidum* are about 2 to 4 μ wide and are found abundantly between the individual cells of the tissue formed of crenately lobed cells; I have observed only a few hyphae within the endodermis in newly invaded needles. In the substomatal cavity a number of hyphae enlarge and acquire a little brown colour; they penetrate the stomate and grow up into the cavity above it, to fill it with a regular mass of large dark walled cells. One or more of these cells grows out into a conidiophore. As seen in Fig. 2A, the xerophytic leaf has a layer of cutin whilst the epidermal and hypodermal cells are small and thick walled. The fungus makes use of the stomata, the only interruptions in the outer reinforced layers, for making an exit. The stomata are in regular lines along the long axis of the needle and even when the conidiophores have been knocked off, the dark-celled contents of the gaping stomatal cavities and the bases of the conidiophores show up as regular parallel

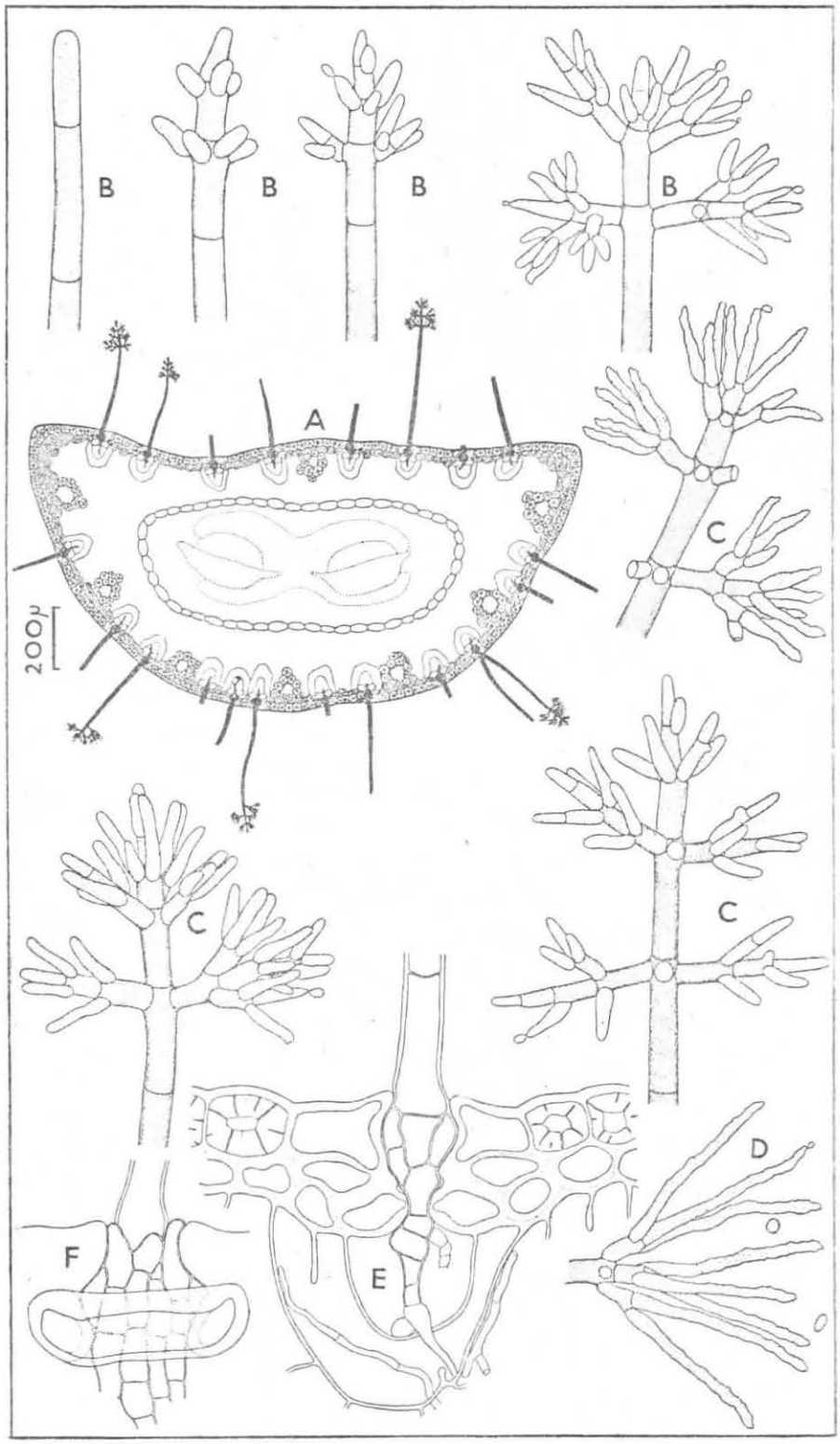

FIG. 2

series of dots. When this is seen in the field then further search is sure to produce needles with unbroken conidiophores.

The apex of the developing conidiophore is more or less hyaline but the dark brown colour soon develops. Below a few of the septa at the apex, a number of bulges appears and these grow out into the lateral branches as indicated in the illustrations (Fig. 2B).

A suggested life-history

Specimens of this fungus have been collected nearly throughout a whole year and from an examination of each needle, an attempt is made to outline its life-history in part at least.

Infected needles as collected in August 1947 are pale brown in colour and apart from the dematiaceous fungus tissue within the stomatal cavities there is no blackening of the surface layers of the host. These needles conspicuously show the regular linear series of conidiophores with a perfect series of developmental stages. Because sporogenous cells increase in length so long as conidia are being produced, the presence of short sporogenous cells constitutes proof that the conidiophore head is a young one.

In August, September, October, and November 1947, conidiophores were observed with very young sporogenous cells measuring only about 14 μ long. I take this to mean that throughout these months new conidiophores were being produced.

The next collection was made in January 1948 but no short sporogenous cells were seen; they were mostly long and presumably no new conidiophores were developing in this month.

In February, March, and April of 1948, collections of the fungus showed only old conidiophores with very long sporogenous cells which were mostly collapsed, distorted, and presumably effete.

In June 1948, sporulating conidiophores were collected again, but it was observed that all the conidiophores were borne on usually much-blackened needles showing the remains of old conidiophores. In this collection some of the stromata in the stomatal chambers had expanded considerably and had formed a raised dome of fungus tissue from which some new conidiophores had developed. In addition, some of last year's broken conidiophores had proliferated to produce another sporulating head whilst occasionally a new conidiophore had proliferated from the broken basal end of a conidiophore of an unexpanded stroma within a stomatal chamber. Whereas in the newly invaded needles the hyphae within the endodermis were very scanty, they were now present in abundance in these more decayed needles.

Such black and rotten needles as these were also found together with the newly invaded ones in 1947 (August–November) and at that time they presented a

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FIG. 2. **Verticicladium trifidum** : A, transverse section through a needle of *Pinus sylvestris* showing the regular intra-stomatal origin of the conidiophores [Herb. I.M.I. 17426(a)]; B, four stages in the development of the apical branches of the conidiophore [Herb. I.M.I. 17426(a)]; C, three branched heads at various stages of maturity [Herb. I.M.I. 17377]; D, a mature primary lateral branch showing elongated and scarred sporogenous cells with two minutely verrucose conidia [Herb. I.M.I. 17377]; E, portion of transverse section through a needle showing a conidiophore base within the stomate [Herb. I.M.I. 17426(a)]; F, portion of a longitudinal section through a needle showing the relationship between conidiophore and stomate [Herb. I.M.I. 17426(a)]. All $\times$ 500 except A, which has a scale provided.

confusing picture because of their large erumpent stromata, in contrast to the small immersed ones of the newly invaded needles.

Pinus sylvestris needles can, therefore, produce at least two crops of conidiophores. Of course, too few collections are available for a complete succession of events to be related but from those already at hand it appears to me that infection of needles, presumably fallen ones, may well occur in late spring or summer such newly invaded needles bear new conidiophores until about November. Conidia are produced until about January and then only effete conidiophores can be found until about June. Presumably the needle in the meantime becomes more and more occupied by fungus mycelium and the host tissues may become blackened near the surface. In June the needles that have already borne a crop of conidiophores the preceding autumn and winter now bear a second crop which appears before the conidiophores on newly invaded needles.

Thus *V. trifidum* has a very interesting life-history and it is to be hoped that it will be investigated far more fully than I have been able to do.

Verticicladium trifidum *in culture*

The conidia of a fresh collection of this fungus did not germinate on potato-dextrose agar but a culture was readily obtained by placing whole conidiophores of Herb. I.M.I. 29494 on agar plates. A wide germ tube grew out from the broken basal end and often the sporogenous cells grew forward as narrow hyphae as well. A completely hyaline colony was soon formed; one six-days-old culture on potato-dextrose agar had reached a diameter of 80 mm. Abundant conidiophores had formed after three weeks on this medium; most of these resembled those produced in nature very closely in development and structure. In addition to the normal conidiophores interesting abnormal ones were produced; two extreme types are illustrated in Fig. 3B. The main stalk of such conidiophores may be slender and quite loosely branched above with only occasional reference to verticillate arrangement of the various lateral branches. The end cells of the branches are sporogenous cells and bear conidia similar to those produced on the natural substratum. This breaking down of the usual closely verticillate nature of the conidiophore head will be referred to later in a consideration of the systematic position of other species referred to the genus *Verticicladium*. I find that on the natural substratum the conidiophores of '*Penicillium elegans* Corda' could break down into a lax form and at once the similarity between this and the same phenomenon in cultures of *Verticicladium trifidum* is striking. In '*P. elegans* Corda', of course, the sporogenous cells are phialides but the general construction of the conidiophore heads in the two species is very similar.

On Quaker-oat agar only a few conidiophores are produced and none at all on filtered maize-meal agar. On Quaker-oat agar the hyphae branch profusely in the upper surface layers of the medium forming a knotted surface growth which becomes brown in parts. On the three media mentioned the mycelial tangle is so tough that the use of a razor blade seemed best for removing portions of a colony.

Excellent growth was produced on a medium prepared by steam-sterilizing

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FIG. 3. **Verticicladium trifidum: A,** three conidiophore heads from 3-months-old culture on chopped *Pinus sylvestris* needles in tap-water agar; **B,** young conidiophore, two conidiophore bases, and two conidiophores showing lax mode of growth from 3-months-old culture on potato-dextrose agar. All from Herb. I.M.I. 29494; ×500.

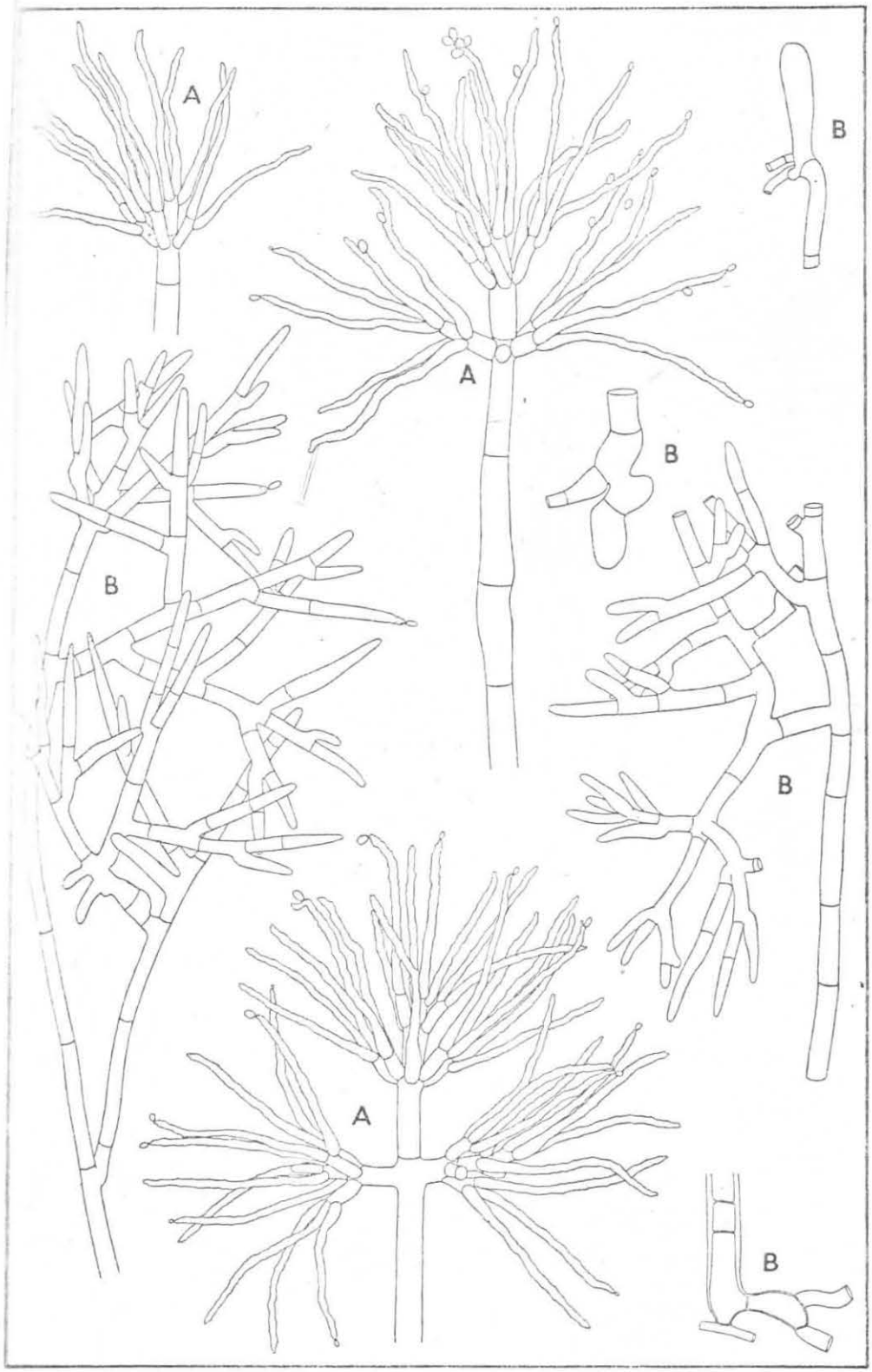

FIG. 3

chopped *Pinus sylvestris* needles in tap-water agar. After three months numerous perfectly formed conidiophores had developed on the actual needles by emerging through the stomata in an orderly manner. Thin black lines composed of continuous vertical plates of compacted mycelium had developed on the medium towards the margin of a colony in the form of an irregular circle with an occasional discontinuous arc. These dark plates, after three months, had developed centripetally on the surface of the medium, here and there to a distance of 15 mm. Conidiophores were produced abundantly on the surface of these black plates. Plate 1, Figs. 4 and 5, show conidiophores produced on this medium.

British records of Verticicladium trifidum

In 1887 Phillips & Plowright made the first British record of *V. trifidum* as follows: 'Our specimens accord perfectly with the figure in Sturm. Deut. Flora., part iii, t. 56. On pine leaves. Near Shrewsbury.' The specimens have not been traced.

In 1893 (p. 386) Massee compiled the species but he cited no specimens.

In 1948 (p. 78) Bramley & Grainger recorded the collecting of *V. trifidum* on *Pinus sylvestris* needles at Swinton (Masham), Yorks., 10th–14th October. This collection is in the Herb. I.M.I. *V. trifidum* folder as 19227(a).

Bonorden and Lindau on Verticicladium

In 1851 (p. 322) Bonorden stated that *Verticicladium* Preuss is *Verticillium*, but he did not make a new combination.

In 1907 (p. 730) Lindau stated, 'I have drawn up the description [of *Verticicladium trifidum*] anew, from Jaap specimens which thoroughly agree with Preuss' figure. Preuss' figure is fairly clumsy and unfortunately I could no longer replace this by an original one. The fungus is much daintier and looks quite like a *Verticillium* with almost entirely trichotomous branching.' He gave the stipe of the conidiophore as 1·5 to 2 μ thick and the conidia as 2·5 μ in diameter. These measurements are quite different from the ones given in my redescription. The Jaap specimens, which I have not seen, were stated by Lindau to occur on *Peniophora karstenii* on pine branches. This is a far cry from the *locus natalis*—pine needles; Preuss's figure is not at all clumsy when compared with material cited in this paper.

A later synonym of Verticicladium trifidum

In 1917 Jaap described a new species of *Verticicladium* on needles of *Pinus sylvestris* as follows: *V. acicola* Jaap . . . 'Konidienträger locker stehend, nicht in dichten rasen, aufrecht, starr, dunkel olivenfarbig, an der Spitze etwas heller, 8–10 μ dick und 400–600 μ hoch, entfernt septiert, oben wiederholt 3 teilig verzweigt, letzte Verzweigungen hellolivenfarbig bis fast farblos, 2·5 μ dick, stumpf, von den Narben der abgefallenen Konidien fast wie gesagt erscheinend, die Konidien einzeln an der Spitze abschnürend; Konidien eiförmig, 5×3·5 gross, farblos, einzellig. Von *V. trifidum* Preuss ist diese Art nach der Beschreibung in Lindau, Fungi imp., [(1907)], S.729, völlig verschieden.'

This description fits the specimens cited in this paper quite well and I take *Verticicladium acicola* Jaap to be a synonym of *V. trifidum* Preuss.

Supposed apothecia

Dr. R. W. G. Dennis kindly drew my attention to an article by J. Gremmen (*Fungus*, no. 3, pp. 32–35, Sept. 1949) in which the author described the conidial apparatus of *Desmazierella acicola* Lib. Apparently this discomycete matures in the spring; the conidiophores were referred tentatively to *V. acuum* Oud. by Gremmen whose figures are very suggestive of *V. trifidum* although his conidia measurements are small for this fungus as described above. (See appendix, p. 25.)

Recent collections maintained in Herb. I.M.I. as Verticicladium trifidum

Date	*Herb. I.M.I. No.*	*Locality*
Jan. 1948	21079(a)	Banstead Woods, Surrey.
Feb. 1948	22594	Richmond Park, Surrey.
1948	23143(a)	Rayleigh, Essex (Coll. Miss P. Hills).
March 1948	25539(a)	Oxshott, Surrey.
1948	27365	Penglais Woods, Aberystwyth, Cards.
April 1948	27480	Swiss Valley, Llanelly, Carms.
June 1948	29498(b)	Richmond Park, Surrey.
Aug. 1947	17426(a)	Richmond Park, Surrey.
1948	31243(a)	Richmond Park, Surrey.
Sept. 1947	17499	Woodbury Common, Devon.
1948	31601(a)	Swinton Park, Masham, Yorks.
Oct. 1947	19227(a)	Swinton Park, Masham, Yorks.
Nov. 1947	19562(a)	Richmond Park, Surrey.

(All collections are on *Pinus sylvestris* needles.)

67. Verticicladium spp.

Apart from *V. trifidum* fourteen species have been described, either as *Verticicladium* or have been transferred to this genus; as far as I am aware the following is a complete list. Some notes are made on a few of them but none I have seen appears to be absolutely congeneric with the type species.

(*a*) *Verticicladium apicale* (Berk. & Br.) Sacc., in *Sylloge Fungorum*, iv, p. 328, 1886, syn. *Verticillium apicale* Berk. & Br. in *Ann. & Mag. nat. Hist.*, Ser. 2, vii, p. 101, 1851. Saccardo regarded *Verticicladium* as dematiaceous *Verticillium* ('Est quasi *Verticillium* dematieum'); it is this idea that resulted in four new combinations of *Verticillium* spp. into *Verticicladium*.

Verticillium apicale and *Verticicladium trifidum* are very different fungi which cannot be regarded as belonging to the same form genus. In the first, the conidia are produced in basipetal succession from verticillate phialides to form slimy heads, whilst in *Verticicladium trifidum* the dry conidia are produced singly at the apex of subulate sporogenous cells as explained above. It seems best at the moment to class Berkeley & Broome's species as a *Verticillium*.

(*b*) *Verticicladium fuscum* (Fuckel) Sacc., in *Sylloge Fungorum*, iv, p. 328, 1886, syn. *Verticillium fuscum* Fuckel in *Symb. Myc.* p. 362, 1869. This was described on decaying leaves of *Quercus* in Autumn in Germany. I could find nothing answering the description on the Herb. R.B.G. Kew copy of the type collection—*Fungi rhenani* 1638. There is no reason why this fungus should not occur in Britain. I have looked for it on rotting leaves of *Quercus* very many times but have seen nothing like a *Verticillium*.

(*c*) *Verticicladium pulvinatum* (Berk. & Curt.) Sacc., in *Sylloge Fungorum*, iv, p. 328, 1886, syn. *Verticillium pulvinatum* Berk. & Curt. apud Berk. in *Grevillea*, iii, No. 27, p. 110, 1875. This was described on *Acacia julibrissin* from South

Carolina, U.S.A., No. 2667. I have examined the type collection in Herb. R.B.G. Kew labelled as above by Berkeley. The pulvinate colonies are very badly squashed and only fragments of conidiophores and possibly one conidium were seen. However, occasional more or less short lateral sporogenous cells were found inserted just below a septum. The whole fungus is pale brown and the walls may be slightly roughened. I could not observe conidial scars on the lateral sporogenous cells and was given the impression that I might have been looking at *Stachylidium bicolor*. On the other hand, the fungus also bears some resemblance to *Nodulisporium* spp., but in order to justify its inclusion in this genus the verticillate sporogenous cells should show conidial scars at maturity.

(*d*) *Verticicladium pulvereum* Peck & Clinton [as P. & C.] apud Peck in *Rept of the Botanist, 30th Rept. of the State Museum, New York*, p. 56, 1876. I have not seen the type collection but Ellis & Everhart, *North American Fungi*, 2874 [Herb I.M.I. (slide) 24009] sub *Verticicladium pulvereum* Pk & Cl. is a *Nodulisporium*.

(*e*) *Verticicladium albo-atrum* [(Reinke & Berth.)] A. L. Smith in *Trans. Brit. mycol. Soc.*, iii, p. 224, 1910, syn. *Verticillium albo-atrum* Reinke & Berth. in Die Zersetzung der Kartoffel, Berlin, p. 75, 1879.

The new combination to this genus seems to have been overlooked; it was made as follows; 'The species has been placed by the authors, as also by Saccardo and Lindau, in the genus *Verticillium*, but the brown colour of the mycelium and conidiophores indicate its position among the Dematieae as *Verticicladium albo-atrum*.' This species is a *Verticillium*.

(*f*) *Verticicladium acuum* Oudemans in 'Contr. Flor. Myc. pays-Bas, xi, p. 50' fide Saccardo, in *Sylloge Fungorum*, x, p. 594, 1892, 'in foliis Abietis excelsæ socio *Vermicularia acuum*, Putten, Hollandiae'.

(*g*) *Verticicladium effusum* Earle in *Bull. New York, bot. Gard.*, ii, No. 7, p. 339, 1902 on languishing leaves of *Coccoloba uvifera* in Florida, U.S.A.

(*h*) *Verticicladium unilaterale* Oudemans in '*Beih. Bot. Centr.*, 1902, p. 17' fide Saccardo in *Sylloge Fungorum*, xviii, p. 627, 1906, 'in ligno quercino putri, Valkenberg, Hollandiae'; see also *Nederl. Kruid. Arch.*, 3 Ser., II, p. 774, 1903.

(*i*) *Verticicladium cheesmanii* Crossland in *The Naturalist*, 1907, p. 98. The type collection is in Herb. R.B.G. Kew, and was collected by W. N. Cheesman on decorticated wood, Stainor Wood, Selby, November 1906 [Herb. I.M.I. (slide) 17378]. Crossland's figure is reproduced in Plate I, Fig. 6. The fungus on the type collection is a *Nodulisporium* and is disposed as such in Herb. I.M.I.; but it is different from the specimen identified as *Calcarisporium arbuscula* by A. L. Smith (1908) and referred to on p. 3.

V. cheesmanii, *V. pulvereum* and possibly *V. pulvinatum* are congeneric. They can be classed in the same form genus as *Botrytis argillacea* Cooke, and the conidial apparatus of *Rosellinia aquila*, *R. thelena*, *R. buxi*, and *Daldinia concentrica*. Similar congeneric conidial structures are frequently met with on dead wood and bark and these forms are probably the conidial apparatus of stromatic Xylariaceae. Until they can be identified with their ascigerous state it is required that they be classed as fungi imperfecti. I do not believe that *Verticicladium* is a suitable genus because its sporogenous cells at maturity are very long and subulate whereas in those collections, tropical and temperate, that I have seen and disposed as *Nodulisporium* spp. the sporogenous cells are short and increase

very little in length because the conidia are concentrated at the apex in such a way that it may even appear bulbous or rostrate.

Nodulisporium Preuss (1862) was published for two species, *N. album* Preuss and *N. ochraceum* Preuss. Although I have no specimens which can be assigned to either of these names, Preuss's drawings, which are fairly accurate (vide *Verticicladium trifidum*) lead me to believe that *Nodulisporium* is the best form genus in which these conidial states can be temporarily disposed. It has already been pointed out that this is the generic name that Molliard (1904) chose when he gave conidial *Daldinia concentrica* a binomial (*N. tulasnei*).

(*j*) *Verticicladium graminicola* Johnston & Stevenson in *J. Dept. Agric. Porto Rico*, I, 4, p. 226, 1917 (as *graminicolum*) on sugar-cane leaves, Porto Rico. Their figure is reproduced in Plate I, Fig. 7.

(*k*) *Verticicladium acicola* Jaap. As previously noted (p. 12) I take this to be a later synonym of *V. trifidum*.

(*l*) *Verticicladium chromosporium* Sousa da Camara in *Revista Agronómica*, p. 9 (in extract), 1931. From the diagnosis and illustrations (Plate I, Fig. 8) this fungus looks like a perfectly good *Stachybotrys*; it arose in a contaminated culture. The author observed that species with hyaline and species with coloured conidia had been included in the genus *Verticicladium* and this, Sousa da Camara stated, disagrees completely with the sections [hyalosporae and phaeosporae] rationally established by Saccardo. The author considered it best to divide the genus 'into two distinct parts, leaving *Verticicladium* Preuss for species with hyaline conidia and erecting, *Dicranocladium* for those with coloured spores'. He intended *Verticicladium pulvereum* (Peck & Curt. [*sic*]) Sacc., *V. cheesmanii*, and *V. chromosporium* to be included in *Dicranocladium*, but no new combinations were made. In 1932 Sousa da Camara (*Revista Agronómica*, xx, 1, p. 63 in extract) cited *V. chromosporium* as a synonym of *Stachybotrys alternans* Bonorden and added 'Veridicum nomen specificum a cl. Dr J. Westerdijk determinatum fuit.'

(*m*) *Verticicladium grewiae* Hansf. in *Proc. Linn. Soc., Lond.*, 1943–44, p. 123, 1944.

(*n*) *Verticicladium ugandense* Hansf. in *Mycol. Pap., I.M.I.*, 15, p. 212, 1946. These last two species are considered to be congeneric with *Botrytis grisella* Sacc. and others, and are included in a new genus described below.

HANSFORDIA (*NEW GENUS*)

From an understanding of the morphology of the type species of *Verticicladium* it became clear that, apart from *V. acicola* (= *V. trifidum*), none of the species described in this genus, or 'transferred' to it, is really congeneric with *V. trifidum*. I consider that the seven species mentioned below, two of which have names in *Verticicladium*, are sufficiently distinct from *V. trifidum* and the type species of somewhat morphologically related genera known to me, and are themselves close enough in structure and habit, to merit the publication of the new generic name *Hansfordia* in which they may be classified.

Hansfordia Hughes gen. nov.

Fungi imperfecti saprophytici vel forsitan hyperparasitici.

Mycelium immersum vel superficiale.

Conidiophora: stipes hyalinus vel brunneus erectus vel repens, directus vel

sinuatus; ramuli laterales primarii fertiles (aliquando steriles vel pro parte apicali steriles), distantes, solitarii vel bini oriundi; ramuli secundarii, ternariique bini et plerumque unilaterales; ramuli in 1–3 cellulis sporogenis denticulatis terminantes.

Conidia acropleurogena, e denticulis truncato-conicis singulatim oriunda, continua, hyalina, sicca, sphaerica, ovata vel fusoidea, laevia vel minute verrucosa.

Species typica: *H. ovalispora* Hughes sp. n. (*vide infra*).

Other species: *H. togoensis* Hughes n. sp. (described below).

H. grewiae (Hansford) Hughes comb. nov.

≡ *Verticicladium grewiae* Hansf. in *Proc. Linn. Soc., Lond.*, 1943-44, p. 123, 1944.

Hansfordia ugandensis (Hansford) Hughes comb. nov.

≡ *Verticicladium ugandense* Hansf. in *Mycol. Pap., I.M.I.*, 15, p. 212, 1946.

Hansfordia triumfettae (Hansford) Hughes comb. nov.

≡ *Sporotrichum triumfettae* Hansf. in *Proc. Linn. Soc., Lond.*, clv, p. 41, 1943 (illustrated in *Mycol. Pap., I.M.I.*, 15, p. 204, 1946).

Hansfordia canescens (Spegazzini) Hughes comb. nov.

≡ *Sporotrichum canescens* Speg. in *Anal. Soc. Cientif. Argentina*, ix, p. 41, 1880 (? reprint).

Hansfordia grisella (Saccardo) Hughes comb. nov.

≡ *Botrytis grisella* Sacc. in *Sylloge Fungorum*, iv, p. 124, 1886, nom. nov. for

≡ *Botrytis griseola* Sacc. in *Mycotheca Veneta* 581, 1876, and in *Nuovo G. bot. Ital.*, viii, p. 195, 1876, non Desmazières (1834).

68. Hansfordia ovalispora Hughes n. sp.

I collected this fungus on old leaves of *Heliconia brasiliensis*, *Saccharum officinarum*, and *Setaria chevalieri* in British Togoland and in the Gold Coast in April and May of 1949. I find no description which might refer to this fungus, which is given the following diagnosis:

Hansfordia ovalispora Hughes spec. nov.

Coloniae effusae, amphigenae griseo-fuscae.

Mycelium immersum et superficiale; hyphis superficialibus hyalinis vel pallide brunneis, rectis vel sinuosis, 1–2 μ latis, e cellulis atro-brunneis, irregularibus, gregariis radiantibus.

Conidiophora solitaria vel 2–3 aggregata e cellulis atrobrunneis oriunda; stipes simplex, erectus, subulatus, usque ad 600 μ longus, inferne atro-brunneus, 3–4 μ latus, superne nonnihil pallidior, 1 μ latus; ramuli laterales primarii 3–4, pallide-brunnei, simplices, plerumque fertiles, solitarii, 25–45 μ distantes, usque ad 80 μ longi, apice sursum curvati; ramuli secundarii pallide-brunnei vel sub-hyalini, bini, plerumque unilaterales; ramuli primarii et secondarii in 1–3 cellulis sporogenis hyalinis, fortiter denticulatis, 10–30 μ longis, 2–3 μ latis terminantes.

Conidia acropleurogena, in apice denticulorum truncato-conicorum singulatim oriunda, continua, hyalina, sicca, ovata, laevia, 8–11 × 4·5–6 μ.

Habitat in foliis emortuis *Sacchari officinari*, Gold Coast (Colony), Takoradi, 10.v.1949, Herb. I.M.I. 38569(a) (typus); Nsawam, 26.iv.1949, Herb. I.M.I.

38596(e); in foliis emortuis *Heliconiae brasiliensis*, Gold Coast (Colony), Aburi, 5.v.1949, Herb. I.M.I. 42140(a); in foliis emortuis *Setariae chevalieri*, British Mandated Togoland, Biakpa Avatime (prope Amedjofe), 29.v.1949, Herb. I.M.I. 39594(b).

Colonies amphigenous, mostly epiphyllous, extensive, and fuscous-grey.

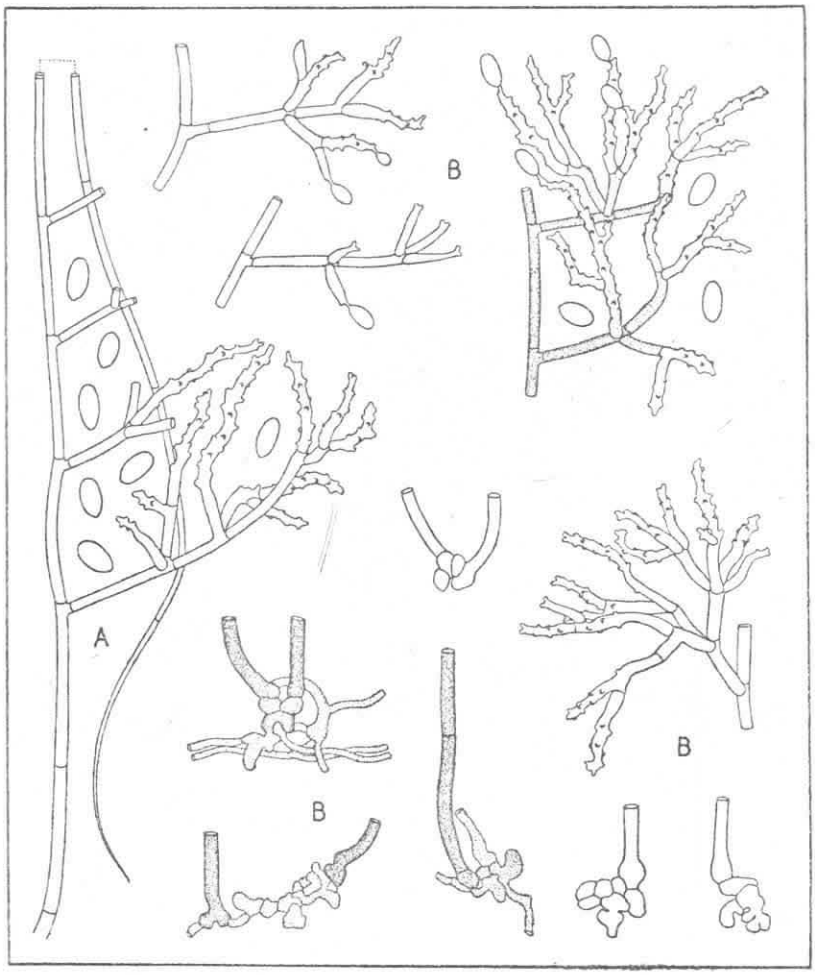

FIG. 4. **Hansfordia ovalispora**: **A**, single conidiophore and conidia from Herb. I.M.I. 38596(e); **B**, bases of conidiophores, lateral branches and conidia from Herb. I.M.I. 38569(a); × 500.

Mycelium at first immersed; later some hyphae emerge through the epidermis or through a stomate and form scattered groups of irregularly shaped dark brown cells (Fig. 4) which may grow out to form an irregular hyaline to subhyaline plate up to 40 μ wide and from which 1 to 2 μ-wide hyphae wander over the leaf surface.

Conidiophores arise singly or in groups of two, rarely three, from the dark brown superficial cells. The main stipe is generally unbranched, more or less erect, straight below, somewhat flexuous above, up to 600 μ long, distantly

septate, 3 to 4 μ wide and dark brown below, tapering subulately to a narrow subhyaline to hyaline sterile apex about 1 μ wide. At 60 to 130 μ from the base the main stipe bears a series of three to four, solitary, brown, primary lateral branches at intervals of 25 to 45 μ; they are 15 to 80 μ long when entirely fertile and stand out almost at right angles to the main stalk, whilst the ends curve gently upwards. Occasionally a lateral branch may be long drawn out to a narrow apex like the main stipe and remain sterile. Usually each fertile branch ends in one to three divergent sporogenous cells whilst towards the stipe they may bear one to three sets of pale brown secondary lateral branches which are generally directed upwards. These too bear two to three divergent sporogenous cells at the apex. The sporogenous cells are subhyaline below and hyaline above or hyaline throughout, usually simple, sometimes branched; they start producing conidia when about 10 μ long, finally reaching a length of about 30 μ; they are 2 to 3 μ wide and somewhat irregular in outline due to the numerous conspicuous flat-topped denticles on which solitary conidia were borne.

Conidia are produced by a swelling out of the abruptly narrowed apex of the sporogenous cell; an oval initial is produced and this is finally cut off by a septum from the denticular conidial stalk. Successive conidia are produced by the development of a succession of new growing-points whose growth is in turn arrested by the production of a single conidium. Mature conidia are oval, dry, smooth, hyaline, continuous, and fall away readily from the sporogenous cell, leaving a conspicuous raised scar on the sporogenous cell and a barely perceptible flat scar on the conidium; they measure 8 to 11 by 4·5 to 6 μ.

Habitat, on dead leaves of *Saccharum officinarum*, Gold Coast Colony, Takoradi, 10.v.1949, Herb. I.M.I. 38569(a) (type collection); Nsawam, 26.iv.1949, Herb. I.M.I. 38596(e); on dead leaves of *Heliconia brasiliensis*, Gold Coast Colony, Aburi, 5.v.1949, Herb. I.M.I. 42140(a); on dead leaves of *Setaria chevalieri*, British Mandated Togoland, Biakpa Avatime (near Amedjofe Pass), 29.v.1949, Herb. I.M.I. 39594(b).

69. **Hansfordia togoensis** Hughes spec. nov.

Coloniae tenues amphigenae, griseo-fuscae.

Mycelium primo immersum, deinde cellulis irregularbuis, atrobrunneis gregariis supra stomatibus vel per epidermidem emergente.

Conidiophora solitaria vel 2–3 aggregata e cellulis atrobrunneis gregariis oriunda; stipes simplex, erectus, subulatus, usque ad 500 μ longus, inferne atrobrunneus, 3·5–4 μ latus, superne nonnihil pallidior, 0·8–1 μ latus, aliquando dichotomo-furcatus; ramuli laterales primarii 2–4, plerumque 3, pallide-brunnei, simplices, fertiles, plus minusve directi, solitarii raro bini, 30–45 μ distantes, usque ad 60 μ longi, aliquando steriles vel pro parte apicali steriles; ramuli secundarii ternariique pallide-brunnei vel subhyalini, bini, plerumque unilaterales; ramuli in 2–3 (plerumque 2) cellulis sporogenis hyalinis, fortiter denticulatis, 6–20 μ longis, 2–3 μ latis terminantes.

Conidia acropleurogena, in apice denticulorum truncato-conicorum singulatim oriunda, continua, hyalina, sicca, fusoidea, laevia, 14–17 × 4·5–6 μ.

Habitat in foliis emortuis *Setariae chevalieri*, British Mandated Togoland, Hohoe, 28.v.1949, Herb. I.M.I. 39596(a).

Colonies amphigenous, mostly epiphyllous, thin, fuscous-grey.

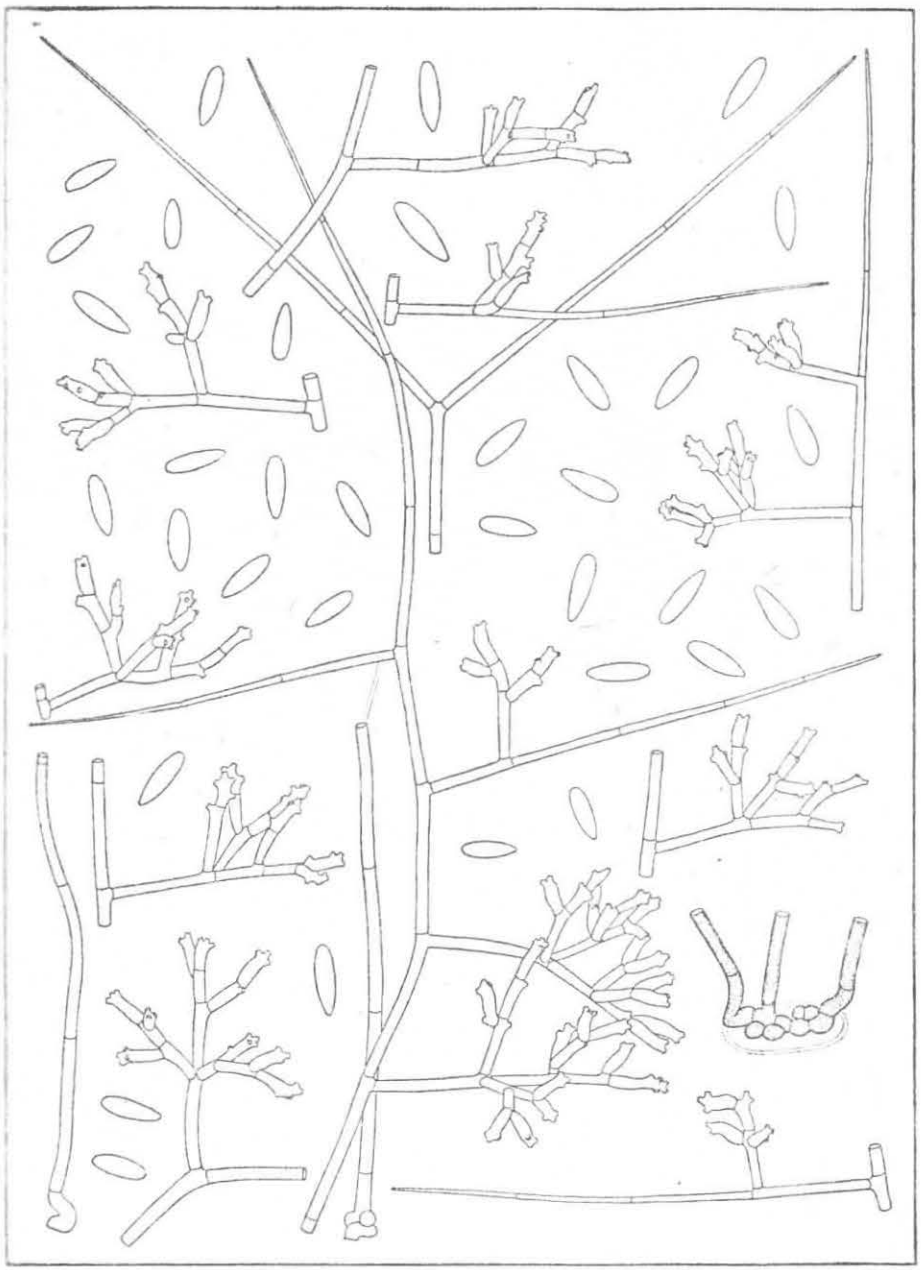

FIG. 5. **Hansfordia togoensis**: bases of conidiophores above stomatal aperture, single conidiophore, portions of other conidiophores, and conidia from Herb. I.M.I. 39596(a); ×500.

Mycelium at first immersed; later some hyphae emerge through the epidermis or more usually through a stomate and form a group of irregularly shaped, dark brown cells. The immersed mycelium is composed of branched, hyaline, septate hyphae.

Conidiophores arise singly but more usually in groups of two or three from the brown superficial cells. The main stalk is generally unbranched, more or less erect, somewhat flexuous or even geniculate along its length, up to 500 μ long, septate, 3·5 to 4 μ wide and dark brown below, tapering subulately to a narrow subhyaline to hyaline sterile apex 0·8 to 1 μ wide; sometimes the main stalk is dichotomously branched above, with each sterile arm 100 to 160 μ long. At 100 to 200 μ from the base, the main stipe bears a series of two to four (mostly three) solitary (sometimes double) brown *primary lateral branches* at intervals of 30 to 45 μ. These stand out either at right angles to the main stipe or are directed slightly upwards; they are more or less straight, and when entirely fertile are 20 to 60 μ long. Quite often they are fertile near the stipe and then long drawn out to a narrow sterile apex like the main stipe; or the upper primary lateral branches in particular may be entirely sterile and long. The fertile lateral branches usually end in one to three (generally two) sporogenous cells whilst further back they may bear one to three sets of two upwardly inserted and directed sporogenous cells or *secondary lateral branches*. These secondary branches may also bear one or two (generally one) sets of sporogenous cells or even short tertiary lateral branches with one to three (generally two) apical sporogenous cells. The sporogenous cells are hyaline, 6 to 20 μ long and 3 to 4 μ wide; along their length they bear scattered flat-topped denticles on which solitary conidia were borne, and whose apices seem to possess a plug of refringent cell wall material.

Conidia are produced by a swelling out of the abruptly narrowed apex of the sporogenous cell; an oval initial is formed and this is finally cut off by a septum from the denticular conidial stalk. Successive conidia are produced by the development of a succession of new growing-points whose growth is in turn arrested by the production of a single conidium. Mature conidia are fusoid, dry, smooth, hyaline, fairly thick-walled, continuous, and fall away readily from the sporogenous cell and show a barely perceptible scar; they measure 14 to 17 by 4·5 to 6 μ.

Habitat, on dead leaves of *Setaria chevalieri*, British Mandated Togoland, Hohoe, 28.v.1949, Herb. I.M.I. 39596(a).

70. Hansfordia grewiae (Hansf.) Hughes.

This was described 'on and around the leaf spots caused by ? *Mycosphaerella* sp.' on *Grewia nyanza* in Uganda. Hansford cited as type his collection No. 3157 but this is probably a *lapsus calami* for 3137 which is represented in Herb. I.M.I as No. 4551(c). The conidiophores are entirely fertile and do not end in a sterile apex as they may do in *H. ovalispora* and *H. togoensis*. The conidia measure 7 to 9 μ in diameter.

71. Hansfordia ugandensis (Hansf.) Hughes.

This was described as parasitic on the stromata of *Cocconia macarangae*

occurring on the leaves of *Macaranga schweinfurthii* in Uganda. Further collections by C. G. Hansford in Uganda, and F. C. Deighton in Sierra Leone show that this fungus can grow in association with *Asterina aulica* Syd. (Herb. I.M.I. 14222), *Cercospora personata* (Berk. & Curt.) Ellis & Everh. (Herb. I.M.I. 28230), *Cerebella andropogonis* Ces. (Herb. I.M.I. 4751), and *Heterosporium adeniae* Hansf. (Herb. I.M.I. 5206). The conidiophores are entirely fertile and the conidia measure 4 to 5 μ in diameter.

72. Hansfordia triumfettae (Hansf.) Hughes.

This was described as parasitic on *Helminthosporium triumfettae*. I have not seen the type collection (Hansford No. 907) but Hansford No. 3144 (= Herb. I.M.I. 4557(b)) is authenticated for this name, and consists of a collection of the fungus growing with *Cercospora* sp. on *Acanthus arboreus*, Kawanda, Uganda, January 1943. *H. triumfettae* is quite hyaline and the conidia measure 3 to 4 μ in diameter.

73. Hansfordia canescens (Speg.) Hughes.

'*Sporotrichum ? canescens*' was described as parasitic on the hyphae of *Cercospora hydropiperis* on *Polygonum hydropiperis* in Argentine. I have not seen the type collection but I take B. Balansa, Pl. du Paraguay, No. 3805 sub '*Rhinotrichum canescens* Sp.' on leaves of *Cassia*, Guarapi, July 1883 [Herb. I.M.I. (slide) 5490, ex Herb. R.B.G. Kew] to be this species. This collection may well be authentic for the name *Sporotrichum canescens*, the fungus is growing in intimate association with a *Cercospora* and the conidia measure 3·5 to 5 μ in diameter or oval and 5 to 6 by 4 μ.

74. Hansfordia grisella (Sacc.) Hughes.

In 1876 Saccardo published *Mycotheca Veneta*. 581 with the following label, '*Botrytis griseola* Sacc. (sp. n.) Bosco Montello (Treviso), in ramis dejectis putrescentibus Cytisi nigricantis, Sept. 1875. Obs. Hyphae fertiles apice saepe cuspidatae nudaeque. Conidia in apice ramulorum glomerata, perfecte sphaerica, 5–6 diam.' I take this exsiccatum to be the original publication of this name.

Later in 1876 Saccardo published the following diagnosis and cited the above exsiccatum, '*Botrytis griseola* Sacc. M[ycotheca]. V[eneta]. n. 581.—Caespitulis floccosis, e griseo-caerulescentibus; hyphis fertilibus assurgentibus rigidulis, medio vage ramosis, parce septatis, apice saepe cuspidatis, nudisque, ramis subverticillato-ramulosis, pallidioribus; conidiis in apice ramulorum asperulo 2-4-glomeratis, perfecte sphaericis, laevibus, 5–6 diam., e cinereo hyalinis. Hab. in ramis dejectis *Cytisi* aliisque in sylva Montellõ, Aug. 1874–75.'

Saccardo (1877) illustrated his species in *Fungi italici* 23 and the figures are reproduced in Plate I, Fig. 9.

The name *B. griseola* Sacc. is a later homonym of *B. griseola* Desm. (1834) and Saccardo (1886, p. 124) proposed the new name *B. grisella* Sacc. to replace it.

Five collections assigned to Hansfordia grisella

I could find no fungus on the Herb. R.B.G. Kew copy of Saccardo's exsiccatum of '*Botrytis griseola*' but the following collections agree with the description and figures:

(*a*) Roumeguère (1882) *Fungi Gallici exsiccati* 2161, sub *Botrytis grisella* Sacc.

on *Alnus glutinosa*, Lyon, France [Herb. I.M.I. (slide) 33733, ex Herb. R.B.G. Kew.]

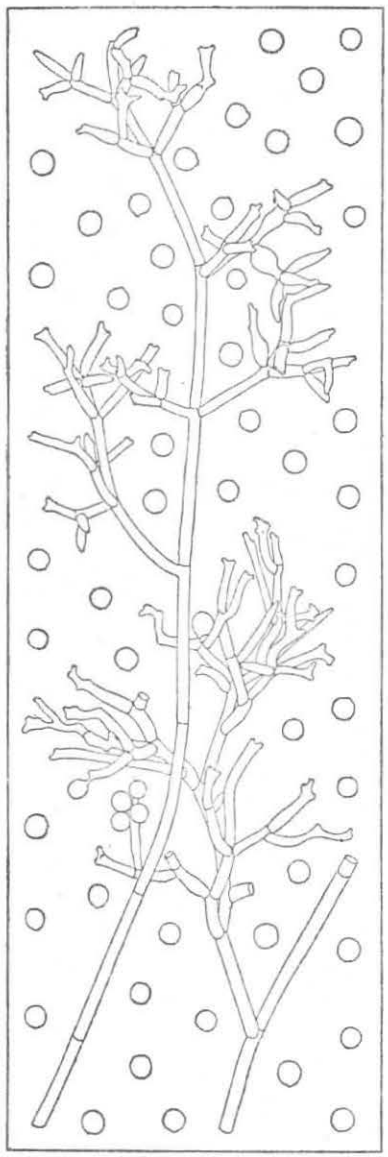

Fig. 6. **Hansfordia grisella**: conidiophores and conidia from three-weeks-old cultures on potato dextrose agar [Herb. I.M.I. 20743]; ×500.

(*b*) Herb. I.M.I. 6699, on *Ulex europaeus* branches, Llanelly, Carms., Wales, 9.viii.1946.

(*c*) Herb. I.M.I. 10550, on *Ulmus*, sp. bark, Cottingham, Yorks., Coll. J. Webster 15.x.1946.

(*d*) Herb. I.M.I. 20743. Dried cultures of fungus isolated from the air in the neighbourhood of Auckland, New Zealand. Communicated for identification by T. R. Vernon (A.21.2) 1947. This isolate is illustrated in Fig. 6 and described below.

(*e*) Herb. I.M.I. 37961, on *Acer pseudoplatanus* bark, High Park Wood, Stanmer, Kent, Coll. P.K.C. Austwick, 9.x.1949. The grey, compact, or somewhat effused tufts of conidiophores are very closely associated with the fructifications of *Stegonosporium pyriforme* (Hoffm.) Corda and the mycelium of the hyphomycete is to be found amongst the exuded pycnospores. In pure culture this isolate resembles that from New Zealand [Herb. I.M.I. 20743].

Description of Herb. I.M.I. 20743

A three-weeks-old culture on potato dextrose agar is pale olivaceous grey, a colour derived from the abundant conidiophores and conidia. The main stipe of the conidiophore is generally unbranched, brown, and 4 to 5 μ wide below, paler and 3 μ wide above, distantly septate; the apical cell of the main stipe becomes differentiated into a sporogenous cell and further increase in length ceases although sometimes the stipe may grow forward into a long sterile hypha as in *H. ovalispora*. The stipe bears a series of solitary, sometimes double, primary lateral branches which are directed slightly upwards. These primary lateral branches bear far more systems of lateral branches than observed in the other species, but the general structure is the same. All branches end in one to three denticulate sporogenous cells. The conidia are produced singly at the growing-point of the sporogenous cells which then develop a new growing-point and growth is finally arrested by the development of a conidium and the process

is repeated; up to six conidial scars have been seen on a single sporogenous cell in a three-weeks-old culture on potato dextrose agar. The conidia are hyaline or very slightly coloured, with an inconspicuous flat scar, smooth and 5 to 7 μ in diameter. They fall away readily from the sporogenous cells leaving conspicuous raised scars.

Note on Botrytis grisella *Desmazières*

Saccardo (1886, p. 124) remarked that *B. grisella* is 'Perhaps not satisfactorily different from *B. griseola* Desm.' Desmazières's (1834) diagnosis would not exclude Saccardo's fungus and because of 52 years' priority held by *B. griseola* Desm. it is worth consideration. Through the kindness of Professor Roger Heim I was permitted to examine a collection authenticated for the name *B. griseola* Desm., catalogued in Herb. Mus. Paris in 1863 and labelled as follows, '*Botrytis griseola*, Desm. Coll. Desmazières. 1863. no. 8 [scripsit?]' [Herb. I.M.I. (slide) 58150]. I saw no conidiophores like those of *B. grisella* Sacc. The collection has not preserved well but I saw some sparingly branched hyaline conidiophores with an apical group of phialides; these conidiophores arise from a pale stroma which seems to envelop an immersed black spored pycnidial fungus (pycnidial ?*Melanconis alni*). This is very reminiscent of the fungus described by Bubák (1914) as *Verticilliodochium tubercularioides* (Speg.) Bubák (≡ *Verticillium tubercularioides* Speg.).

The systematic position of the genus Hansfordia

The main character which serves to differentiate the species classed here in the genus *Hansfordia* from other morphologically related genera is the denticulate nature of the more or less cylindrical sporogenous cells. These denticles are not restricted to the immediate, sometimes swollen apex, as in the subulate sporogenous cells of *Calcarisporium arbuscula*; in any case the latter usually has simple conidiophores with regular verticils of sporogenous cells inserted directly on the main stipe.

In *Hansfordia* spp. the primary branches are generally solitary on the main stipe, but the secondary and tertiary branches are usually in pairs, unilateral, and directed upwards. These branches may terminate in two or three sporogenous cells, but of these one or two are lateral and the other is the modified continuation of the primary, secondary, or tertiary lateral branch. True verticils, which I take to mean three or more laterals arising at a common level, are absent.

It will be observed from Figs. 4, 5, and 6 that a loose arrangement of branches is to be found in *Hansfordia ovalispora*, *togoensis*, and *grisella*, and indeed the other species, whereas the primary, secondary, and tertiary lateral branches of *Verticicladium trifidum* form a regular and compact head at the apex of an obviously differentiated stipe (Fig. 2). In culture, however, the normally compact conidiophore head of *V. trifidum* can break down, and a loose branching system is produced instead (Fig. 3); this is not unlike the type of conidiophore produced normally by *Hansfordia* spp. but the conidial scars on the sporogenous cells of *V. trifidum* are quite minute and contrast strongly with the denticles on those of *Hansfordia* spp. Unlike *Hansfordia* spp., *V. trifidum* shows a specialized host relationship.

75. ? Other Hansfordia spp.

(*a*) *Trichosporium arborescens* Penzig & Sacc. (1904) may well be congeneric with *H. ovalispora*; their original figures are reproduced in Plate I, Fig. 10.

(*b*) *Cladobotryum australe* Viégas (August 1946) was described as parasitic on the colonies of *Septoidium didymopanacis* Viégas. Indeed, from the figures (reproduced here in part in Plate I, Fig. 11) and description, the fungus is quite close to *Hansfordia ugandensis* (≡ *Verticicladium ugandense* Hansf., April 1946).

Viégas's use of the generic name *Cladobotryum* is interesting. This name was published by Nees (1817) for a single species *C. varium* Nees [= *Dactylium varium* (Nees ex Fr.) Fr. in Syst. mycol., iii, p. 414, 1832]. I do not think that anyone has redescribed this type species under this name and in view of the incomplete description it does not appear to me possible to use the name with any certainty of its correct application. v. Höhnel (1923) doubted whether *Cladobotryum* sensu Saccardo was different from *Calcarisporium* Preuss. Petch (1932) used the name *Cladobotryum* for two fungi, which, from the figures and descriptions, seem congeneric with *Calcarisporium arbuscula*, as was indeed suspected by Petch.

(*c*) *Verticillium cercosporae* Petrak & Ciferri (1932) was described as parasitic on *Cercospora* spp. in the Dominican Republic. The conidia were stated to be acropleurogenous and 4 to 6 by 3·5 to 5 μ or 3 to 5 μ in diameter. This is very probably a *Hansfordia*.

(*d*) '*Botrytis melanopsammopsidis*' (nomen nudum in Stahel, 1917). Stahel described and illustrated a '*Botrytis*' parasitic on *Melanopsammopsis ulei*. The fungus is a *Hansfordia* with conidia 7 to 10 (mostly 8–9) μ in diameter and close to *H. grewiae* in this respect. Stahel stated that *Botrytis melanopsammopsidis* would be a suitable name for the fungus if it were found to be a new species.

[*Botrytis cercosporaecola* Hara (1929) was described as parasitic on *Cercospora kakivora* Hara in Japan. The conidia were described as spherical, ovate, or elliptical, hyaline, and 4·4 to 8·8 by 3 to 4·4 μ, but considering Hara's illustration the fungus does not appear to be related to *Hansfordia* in any way.]

For permission to examine collections in their keeping I am grateful to Miss E. M. Wakefield of Herb. R.B.G. Kew and Dr. J. Ramsbottom of Herb. Brit. Mus. (Nat. Hist.). Miss Wakefield also kindly corrected the latin diagnoses.

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APPENDIX

In June 1950 Miss J. W. Graham obtained a culture, identified in Herb. I.M.I. as *Verticicladium trifidum*, from a small portion of an apothecium [Herb. I.M.I. 43462(a)] of *Desmazierella acicola* which had been thoroughly washed in sterile water and plated out on to potato-dextrose agar.

EXPLANATION OF PLATE I

FIG. 1. A. L. Smith (1908) sub *Calcarisporium arbuscula* Preuss.

FIG. 2. *Verticillium beauverioides* after Vincens (1923).

FIG. 3. *Verticicladium trifidum* after Preuss (1862).

FIG. 4. *Verticicladium trifidum*: a tuft of conidiophores from a 3-months-old culture of Herb. I.M.I. 29494 on tap-water agar and chopped *Pinus sylvestris* needles; the scale = 200 μ.

FIG. 5. *Verticicladium trifidum*: apex of conidiophore from same culture as Fig. 4; the scale = 20 μ.

FIG. 6. *Verticicladium cheesmanii* after Crossland (1907).

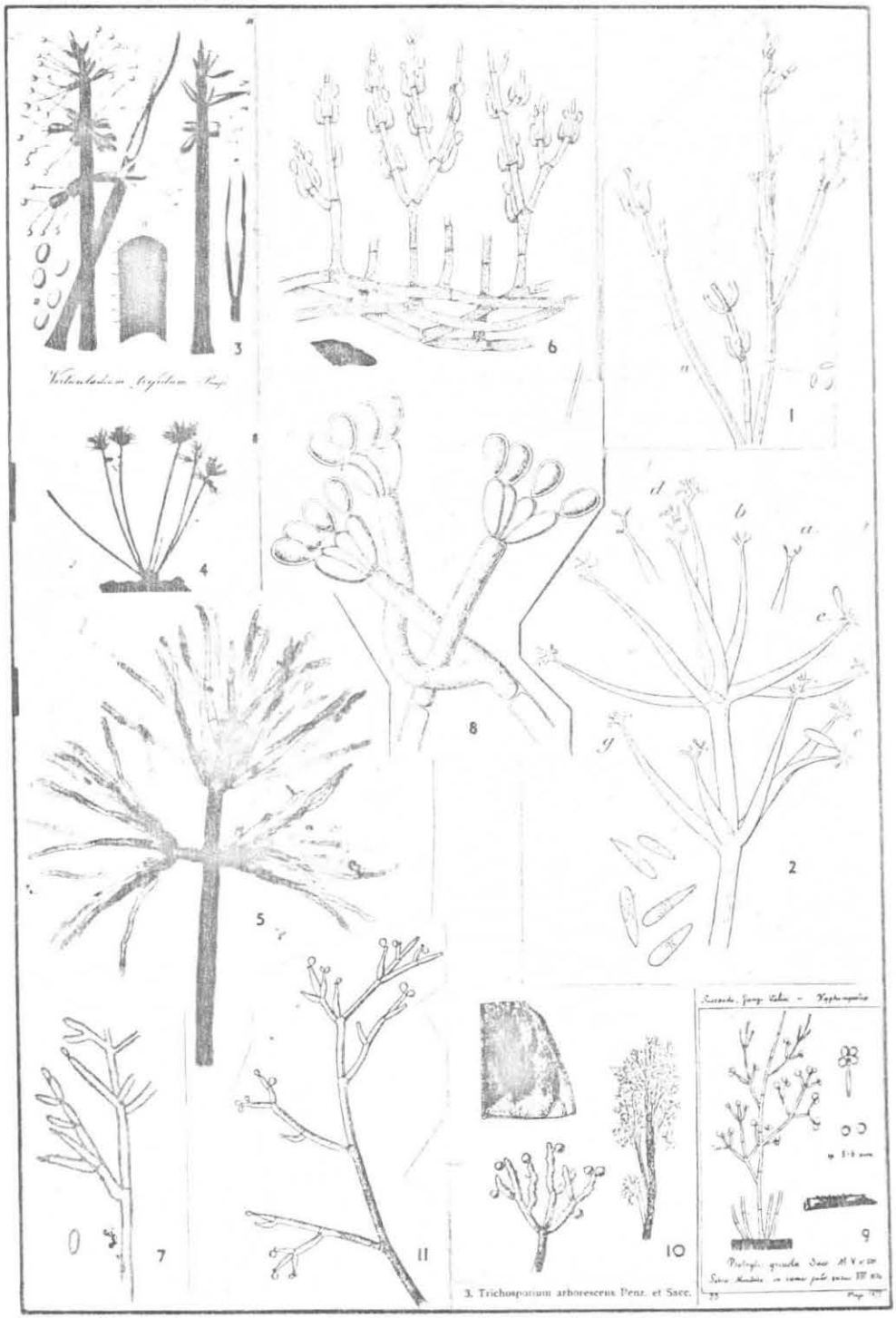
FIG. 7. *Verticicladium graminicola* Johnston & Stevenson.

FIG. 8. *Verticicladium chromosporium* Sousa da Camara.

FIG. 9. *Botrytis grisella* after Saccardo, *Fungi italici*, 23, 1877.

FIG. 10. *Trichosporium arborescens*, after Penzig & Saccardo (1904).

FIG. 11. *Cladobotryum australe* after Viégas (1946).



3. Trichosporium arborescens Penz. et Sacc.